
Space Weather Technical Forecast

Issued on Friday, 07 October 2022 at 13:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Residual Slight Chance of G1 from CME today. Reduced daily Chance of M-class flares throughout. Active electron fluence Expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with background X-ray flux measured at GOES16 and 17 skirting the B/C boundary, with occasional low-level C-class flares recorded. The largest of these flares was a C3.3 at 07/1137UTC from AR3116. Also of note was a long-period C2 flare tied to a possible filament lift-off in the northwestern quadrant that started around 07/0730UTC, perhaps nudged to C2.4 around 07/0850UTC by concurrent brightening of both AR3112 and AR3116 nearer the meridian. Imagery to determine the trajectory of any ejecta from the filament is not yet available, however is a source of active monitoring. At the current time, no Coronal Mass Ejections (CMEs) were seen in imagery.

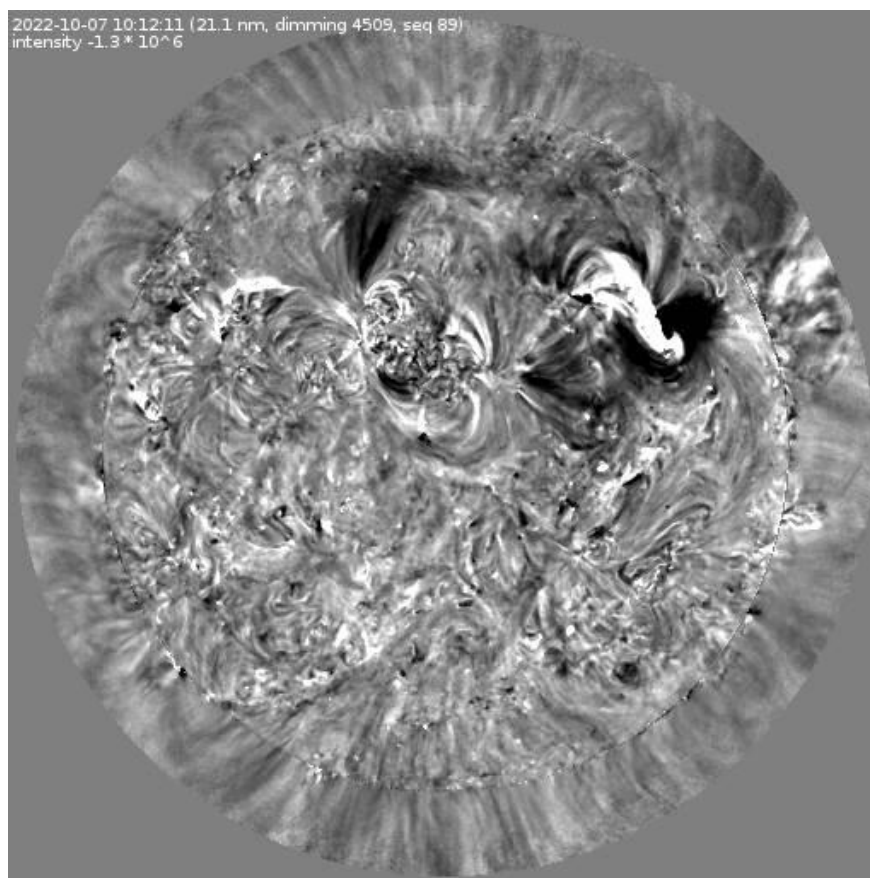


Figure 0: Time-integrated AIA211 image sequence of the northwestern quadrant dimming tied to the observed long-period C2 flare and filament eruption. The resulting CME will be

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analysed when it presents for analysis. Image processing courtesy of SIDC ROB.

There are now seven numbered sunspot regions on the disc, with the development and numbering of a new Bxi/Beta bipolar region in the northeast now designated AR3119. As in recent days, the disc is dominated by the presence of the very large span of AR3112, which sprawls across 22 degrees of solar longitude, although this showed a slight decaying tendency in terms of area to near 700mhs from 750. The main potential 'threat' appears to be its contorted central portion, which contains a candidate for a Mt Wilson Delta spot, as well as the twisted magnetic neutral line that has led to it being classed as a Gamma, which considered together have led to its Fki/BGD classification. As well as this region, its immediate northern neighbour AR3116 was the other noteworthy occupant of the front-side, showing slight proliferation of its intermediate spots to be classed Dai/Beta. The remaining spots were small, and either stable or in decay, with little accompanying activity noted.

Solar Wind / Geomagnetic Activity: Solar winds observed by DSCOVR at L1 are a reasonable analogue for those seen at STEREO A 1.5 days upwind, and Earth is now considered likely to be sampling the tail end of CH28/+ or CH30/+ (now both on the northwestern limb), with the phi angle accordingly positive throughout (away from the Sun). There may also be minor transient activity mixed in to bolster the usually quiet tail of the incumbent coronal hole, although this is not conclusive.

The solar wind speed itself showed a gradual decline from around 500 to 450km/s, before a late recovery in lost ground from 07/1000UTC. Meanwhile, the density initially fell from around 10ppcc into more typical single figures before also recovering. The IMF was relatively stable near 8nT at peak, with an erratic north-south component between +6 and -7nT.

The net result of these solar wind measures was for mostly Active Kp indices, peaking at a provisional '4o' in the 21-24UTC interval. A possible reason for the sustained elevated activity seen may be some minor component of a CME, else the frequent changes in the orientation of the field vector and/or the strength of the connection to a positive polarity coronal hole near the autumnal equinox, although these are not conclusive surmises.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at Background levels.

High energy electron flux (greater than 2 MeV) has increased to a relatively flat diurnal oscillation about the Moderate and High flux boundary, peaking at 2.40e3 pfu at 06/1630 UTC. Associated electron fluence was mostly a little below the Active threshold, but with a slowly increasing trend to peak at 9.54e7 at 07/1200UTC. The observed fluence at 07/0001UTC was 6.25e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity carries a now reduced Chance of reaching Moderate, with the main risk predominately attributed to the large northern sunspot AR3112. No significant regions leave the disc in the period, and one forecast arrival later in the UTC weekend has yet to present for analysis, leading to a flat risk trend throughout.

Solar Wind / Geomagnetic Activity: The possible filament eruption mentioned in the Solar Activity section does not feature in this forecast, pending imagery for analysis.

The only transient that does potentially feature in the forecast is the CME from a filament eruption in the southern central disc on Tuesday 04 October, which may still arrive at Earth imminently. Any forecast effects have been accordingly reduced for it being a later, slower and presumably less impactful arrival. This may still lead to a resurgence in Elevated winds, but the

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chances are now Slight.

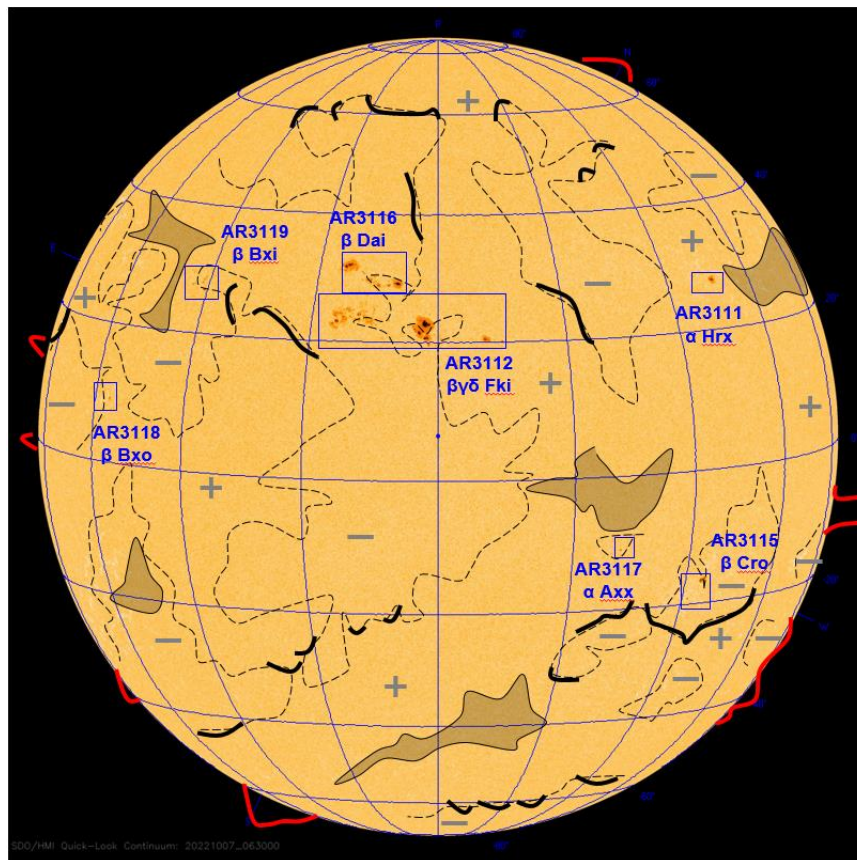
The residual fast wind from CH28 or CH30/+ should abate in earnest over the remainder of day one (Friday 07 October), but with Active intervals remaining Likely as it does so - this based on its observed (perhaps impure) character and our proximity to the autumnal equinox. The next fast wind enhancement is then due either later day 2 (Saturday 08 October) or day 3 from CH29, the risk continuing into early day 4.

Geomagnetic activity is Likely to remain Active in the immediate term, with a now reduced Slight Chance of G1, from here reducing to perhaps become Unsettled for a time early day two (Saturday 08 October). There is then a resurgent Chance of Active intervals and a Slight Chance of G1/Minor Storms again from the forecast fast wind arrival from CH29, probably peaking on day 3 (Sunday 09 October).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near Background for much of the period, but with a now reduced very Slight Chance of minor proton storms, most likely due to AR3112.

Electron flux is currently showing a damped oscillation between Moderate and High flux, with Active 24-hour fluence nearly realised. The chances of this continuing are 'near-evens', but perhaps slightly above 50% into the coming UTC weekend, falling to slightly below by the new working week.

Figure 1. Solar Analysis Valid 07/0630UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption around 04/1300UTC resulted in a CME that was analysed as passing mostly to the south of Earth on Thursday 06 October. This feature is now significantly late, and may have already passed 1AU - there was a minor discontinuity seen in ACE EPAM LEMS low-energy protons around 06/1000UTC, which may be related. With this far from conclusive either way, its forecast likelihood has been adjusted downwards (should it still be en route) for being later, slower and of potentially more glancing incidence. A minority of MOSWOC Enlil ensemble members still suggest a surviving vestigial Slight Chance of arriving at the very start of the current forecast period.

The above is the only transient in the forecast, with any ejecta from the 07/0730UTC filament lift off in the northwest quadrant yet to appear on coronagraphs.

In terms of coronal holes, CH29/+ is a new feature west of central disc. With Earth now exiting the fast wind from CH28/30/+, further slight enhancement is likely later day 2 (Saturday 08 October) or during day 3 as Earth encounters its fast wind. This low confidence however, due to a lack of persistence, and also no notable signal from this feature being present in current MOSWOC Enlil model winds.

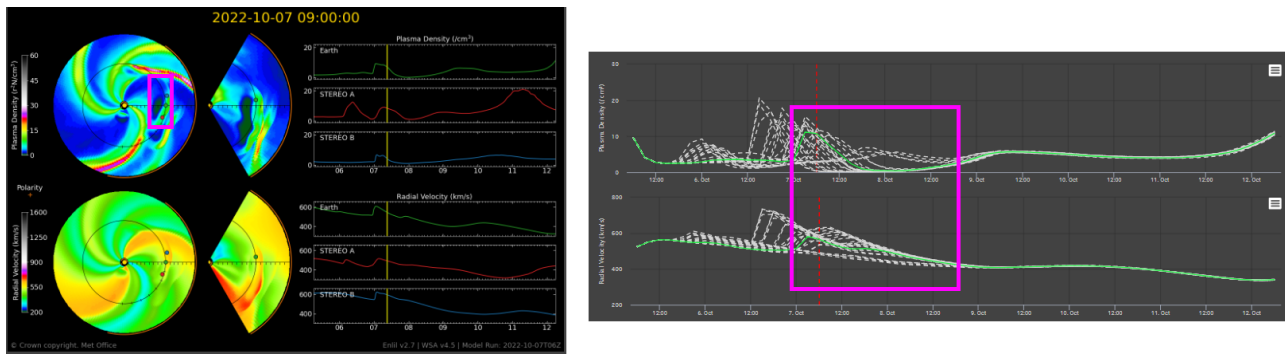
Geomagnetic activity is Likely to remain Active in the immediate term, with a now reduced Slight Chance of G1, from here reducing to perhaps become Unsettled for a time early day two (Saturday 08 October). There is then a resurgent Chance of Active intervals and a Slight Chance of G1/Minor Storms again from the forecast fast wind arrival from CH29, probably peaking on day 3 (Sunday 09 October).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	10	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1734	Partial	Filament	SW	980km/s	Imminent, else missed Earth	Perhaps now most likely passed 1AU

Figure 2: MOSWOC Enlil, showing the 04 October CME boxed magenta – with some outlying ensemble members suggesting a glancing blow remains a small possibility.



Radio Blackouts - X-Ray Flares:

Solar activity is currently significantly below expectations given the nominal complexity of the disc.

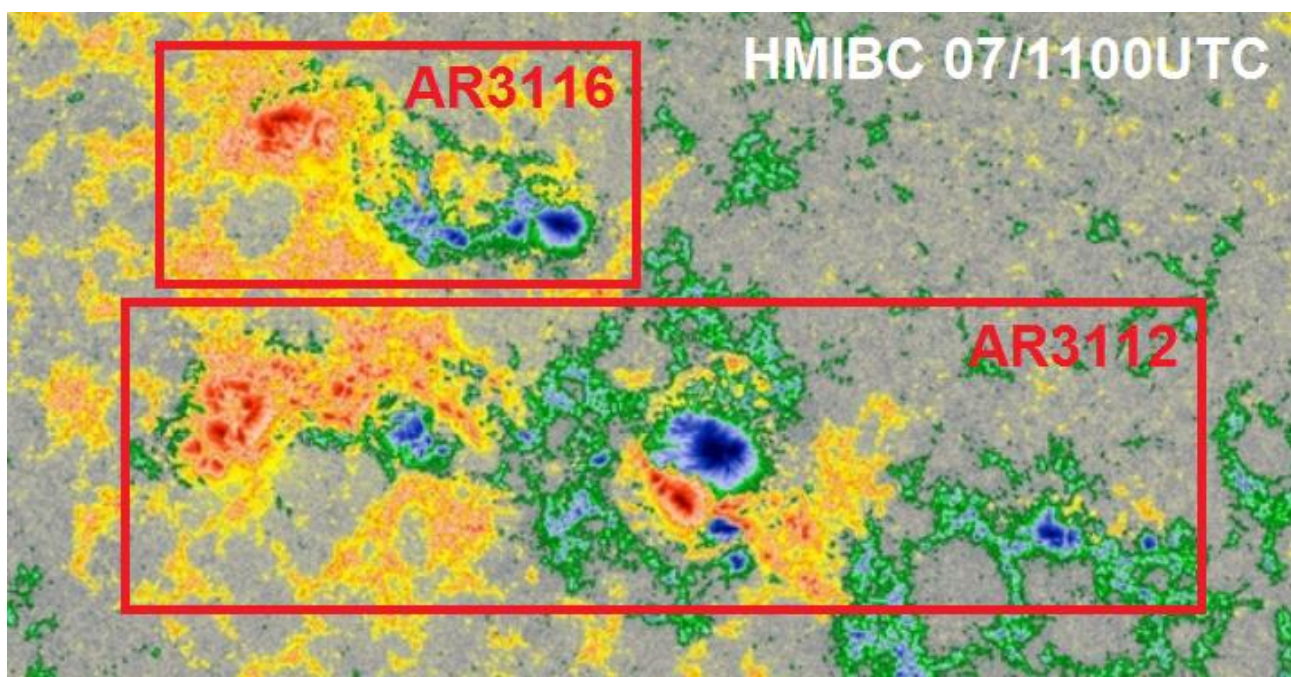
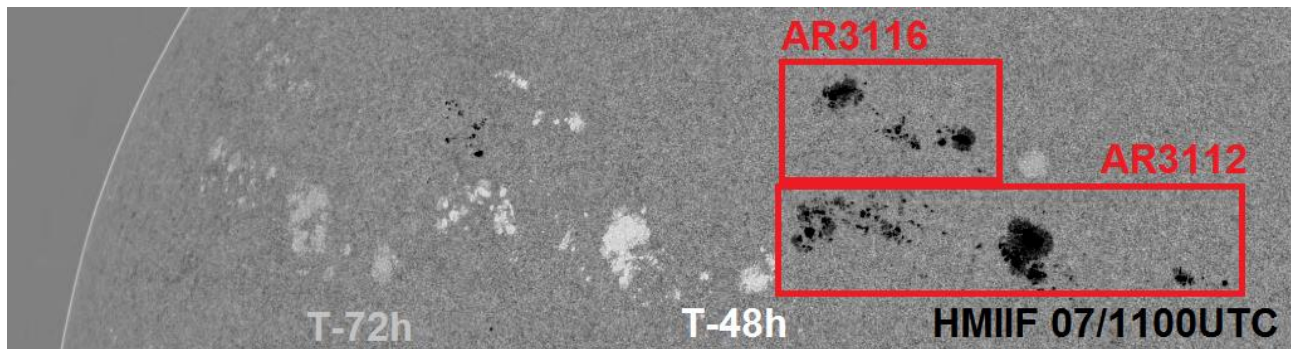
A large part of the rationale for high probabilities is the expansive AR3112, which has been given Fki/BGD classification. The risks of notable flares attributable to spots of this class is significant, however it is perhaps felt that the observed lack of activity; the recent areal decrease; the sparse nature of much of the group; and the possibility that it may be alternatively partitioned into at least two separate regions - all factor into the decision to decrease daily X-ray flare probabilities. The one main caveat to this is the possible presence of a candidate for a Mt Wilson delta spot in its central portion - it would not take much of a reconfiguration for this to become highly unstable and significant flares to result.

Including AR3112, there are seven sunspot regions in total on the current disc, most of which are stable or decaying and magnetically simple. The only real exception and potential 'partner in crime' to the aforementioned AR3112, is AR3116 to its immediate north. It appears that the whole complex set of spots in the central northern hemisphere is perhaps feeding off the same sub-(visible) surface 'hotspot'. A slight proliferation of the intermediate spots was seen in recent hours as well as a spreading tendency, although this group remained a Dai/Beta with no significant flares.

Ex-3102 may lie just over STEREO A's eastern horizon at present, which puts any Earth-side arrival later in the coming UTC weekend. Any contribution to flare risk remains to be seen, however. Meanwhile, none of the more significant front-sided regions are due to depart the western limb, which (all considered) means that the flare risk is held at a lower-than-recent-days constant level throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Helioviewer.org-derived HMIIF running difference imagery for the present time (black footprints of spots), as well as T-48h and T-72h, showing trends in AR3116 and AR3112. Also shown (below) is an HMIBC image, showing the potential Mt Wilson delta spot in the centre of AR3112.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is currently at Background levels.

Because of the relative lack of even minor flares, as well as the potential for AR3112 to comprise at least one group (rather than a very large Fki/BGD), the relative chances of S1 or greater have been adjusted downwards a little in the near-term, only increasing with the typical westward advance of all spots on the disc.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

The past 24 hours have seen high energy electron flux undergo a change in character to follow a damped oscillation near the High flux boundary, with the result that Active 24-hour integrated fluence is now nearly being realised, but with a forecast that carries greater than average uncertainty.

The fact that coronal hole 29 is not a persistent feature; the fact that there may still be an outstanding transient (from 04 October); and perhaps also one from the northwestern 07/0730UTC disappearing filament; all factor in to a forecast with a risk of Active that is 'near-evens'.

All considered, beyond day one, this risk perhaps is slightly above 50%, trending to slightly below should geomagnetic activity increase for a time as expected in CH29.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	90	60	60	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1